means of protection against the exciting cause of acute inflammation. And to impart a healthy sensibility to the cutaneous surface, and secure a vigorous vital resistance, the body should be daily bathed in cold water, and freely exposed to the cool air; avoid exhausting exercises, and the influence of narcotic poisons; and use a diet reasonably rich in hydro-carbons.

ART. VI.—*The Microscopical and Histological Relations of Enchondroma.*

By W. J. BURNETT, M. D. [With three wood-cuts.]

FOR the first description of this adventitious growth, as a product quite peculiar in its nature, we are indebted to Müller.

In the year 1836, at an anniversary of the Military Academy of Berlin, he alluded to some of the relations of this disease. But, two years afterwards, a very comprehensive description of it appeared in a work[*] quite remarkable for its time; and upon these labours of Müller may be said to be founded all our subsequent knowledge and descriptions of this product. He recognized the species, and so, in the consideration of the subject, we necessarily fall back upon the original description. This, however, is too well known to be quoted here; the disease is recognized as a formation of rather uncommon occurrence, and composed of a tissue exactly resembling that of normal cartilage in some of its earlier and in some of its transitory conditions. On these accounts it has, since Müller's description, been much more carefully described than other growths of an equally innocent nature. The number of alleged cases found in the records of medical science is comparatively small; and, in reading over the accounts of them, we cannot help feeling that much less obscurity would exist as to the true nature of many of them, had the observers, in their examination of its structural and other peculiarities, been as thorough as was Müller. For there are many fibrous tumours which, in all their gross aspects, so closely resemble true enchondromata, as not to be distinguished from them, except by a microscopical or chemical analysis; and in this fact, the value of which, in an histological point of view, cannot here be too strongly insisted upon, may be found the reason of some of those curious cases that have been recorded, and to which we shall soon have occasion to refer.

From the equally innocent nature of fibrous and enchondromatous tumours, the relations which they sustain to the surgeon, who is looking merely to the practical result, are the same. But the case stands otherwise with the physiological pathologist, who is seeking to thoroughly understand the relations which homomorphous morbid products hold to normal tissues. And the time has now arrived, I think, when these can be considered so important that no surgeon or medical man, however eminent he may be in the practical departments of his science, can be justified in pronouncing and recording his opinion of a morbid growth, unless it has been founded upon a careful analysis, either microscopical or chemical, of its structural characteristics.

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[*] Ueber den Feinerin Bau der Geschwülste. Berlin, 1838, pp. 31–49: or its translation by Charles West, M. D., London, 1840, pt. i. pp. 96–152.

According to Müller, enchondroma exists under two different relations, viz.: 1st. That connected with the bones; 2d. That of the soft parts.

Both the experience of Müller, and that which has been recorded subsequently, go to show that nearly every case of true enchondroma is in some way connected with the osseous system. In examining the recorded cases, as far as the literature of the subject has been accessible to me, I have found very few of which the nature was not doubtful, and which were met with in the soft tissues, isolated from osseous and cartilaginous parts. And, even of these last, I have been inclined, from histological motives, to entertain the opinion that *they* also necessarily had a primary connection of this kind.

Their origin and development in, or upon, tissues to which they are allied histologically, are not surprising, for it supposes the perversion of a normal blastema existing under normal relations, and is in accordance with the law of analogous formations; it is then an *epigenesis*. But their appearance, quite isolated from these tissues, and in parts which sustain no relation, embryologically or otherwise, with cartilage, does not admit of so easy a solution, and its consideration demands our attention for a few moments. We have already seen how great is the disproportion in number between even *all* the *alleged* cases of this last, and those in which there is a natural connection with allied tissues; and this is made still greater by the omission of those in which the evidence of their peculiar nature was based upon their gross appearance only. So that, if it *ever* does really occur, it must be considered as the rarest exception.

All the most careful studies made, and all the most thorough knowledge acquired, concerning the primitive relations of animal tissues, invariably point to one law, which, in virtue of its very nature, can have no exceptions. This is, that a tissue having been evolved, there has necessarily been the previous existence of its germ or blastema, from which alone it could have taken its origin. In the development of the ovum out of an homogeneous material, the allocation of the different tissues depends upon the type-power which it inherits from the parent, and which constitutes the first expression of its individuality as a separate being. After its evolution in this manner, the persistence in each tissue of its own special type-power is the reason why any loss sustained is made up by the appearance of a similar tissue in its place, and elaborated from one common nutritive fluid, the blood. And, did this not exist, we might well expect that glandular, or any other tissue would be found as the material of repair in fractured bones, instead of that which is, or is to be, identical with the part taken away or with those to be united.

It would, therefore, appear that our best views of histology, based upon the most careful experience, all go to show that, a set of tissues having been formed and existing under *normal* relations, their subsequent increase and reproduction must occur according to the law of analogous formations, and as the result of their special type-power. This at once settles in the negative the question whether, in normal structures, there can occur spontaneously one tissue in another of a very different nature. In morbid tissues we naturally look for the same results; for, as yet, there is no evidence that the laws regulating *abnormal*, are different from those of *normal*, products.

If in a glandular organ, such as the mammary gland, testicle, &c., there can be *created* a new blastema, and which is different from that of the tissue in which it is developed, this fact at once introduces a new feature into our knowledge, not only of the relations which tissues sustain to each other, but also to the individual which they compose. In fact, I may say that it is about equivalent to the admission of the doctrine of *spontaneous generation.* And although, according to our best views in physiology, there should be a distinction drawn between the real significance of these two facts should they occur—viz., 1st, of the *creation* of an entozoon in the living tissues; and, 2d, of the *creation* of a cartilaginous tissue in the midst of others to which it is in no way allied; and this should be so because the entozoon has an individuality of its own, while the cartilage has not—yet they have some points of analogy, and I can readily see how the admission of the latter as a scientific truth would shake our belief in the *impossibility* of the former.

And, finally, I may say that I am satisfied that, in considerations of this kind concerning the fundamental relations of tissues, the *teleological* must always be taken instead of the *physical view* of the subject; for experience has shown that it is not only the surest guide with doubtful points, but is constantly enabling us to recognize and correctly appreciate natural phenomena.

From these remarks, it will be seen that I am inclined to a disbelief in the occurrence of true enchondromata in the glandular and other soft tissues, isolated originally from those of either bone or cartilage. This same would, of course, be true as to true osseous tumours in the same localities—for true osseous tissue is always preceded by that of cartilage.[*]

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[*] I know that it is usually written that bone is formed in either *cartilage* or *membrane* —an opinion of about a hundred years old, based upon the appearances seen in the formation of the tabular bones of the cranium. But, as this matter is important in this connection, it may be well to state how it stands. Since then, and within twenty years, the investigations of E. H. Weber (Hildebrandt's *Handbuch der Anatomie, &c.*, tom. i. p. 333) and Miescher (*De Inflammatione Ossium, &c. &c.*, Berlin, 1836, p. 15) go very far to show the constant pre-existence of cartilage, and are the more important because made upon these cranial bones. Within a recent period, however, Dr. Sharpey (*Human Anatomy*, by Jones Quain, edited by R. Quain and Wm. Sharpey, Amer. edit., by Dr. Leidy, vol. i. p. 83), after microscopical examinations, advocates the old opinion. My own view is that, in all cases of true bone having Haversian canals and Purkinjean corpuscles, it is formed *in cartilage.*

We know very well that the most thorough studies of the origin and nature of epithelial morbid growths show that they *always* have a primitive connection with the normal tissue of this kind; in fact, are always *epigeneses*, although, in some instances, the conditions of the surrounding tissues are so changed that these earlier relations cannot be traced, and the product seems so isolated from any part to which it is histologically allied; and, even now, there are pathologists of note who maintain that often these growths are entirely new formations from the beginning.—(*Rokitansky* and *Cruveilhier.*) In these facts may be found a solution of some of the difficulties with which we meet in the subject under consideration.

We will now turn to the review of some of these cases as they have been recorded; but, at the same time, I will remark that my own experience with fibro-plastic and cartilaginous tumours has shown me that the opinion of any man, however eminent he may be in the practical duties of surgery, *cannot* be relied on, when based simply on the gross aspects of the product; for, in many instances, there are no leading external features by which the distinction of quite different growths can be made.

Those cases, in which growths alleged to be cartilaginous have been found about the tunics of the testicle, must be regarded doubtful, since this view of their nature is based upon mere external aspect; at least, it is true of all the cases I have met with in medical works since the times of Sir Astley Cooper, and even before. I have never seen and examined examples of this kind, but the very description given by Cooper* renders the matter doubtful. He says they are smooth, like cartilage, externally; but, internally, are cretaceous, which makes it very probable that they are fibro-plastic tumours, taking their origin from the fibrous tissue of one of the tunics (in fact, they are sometimes thus attached),† and subsequently having in their centre a deposit of cretaceous matter, which, it is well known, is not rare in similar growths in other localities.

For the same reasons, I cannot admit, as *veritable* cases of enchondroma, those few that have been recorded of alleged cartilaginous tumours found in the peritoneal cavity, or attached to the peritoneum.‡ And I have every reason to believe, from my own examinations, that they are of a fibrous nature. The same is also true of those attached to the serous membranes of the chest; and here I will add that, not a great while since, a small tumour was found after death attached to the pleura, and which, both from its feel and external and internal aspects, could not, I am convinced, be judged otherwise, was regarded as a true cartilaginous formation; yet the microscope showed it to be simply *fibro-plastic*, the fibrous tissue having a somewhat reticulated arrangement. Had it not been microscopically examined, it would have been preserved in spirits as a real enchondroma of the pleura.

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* Observations on the Structure and Diseases of the Testis, Amer. edit., Phil., Lea & Blanchard, 1845, p. 217.

† See a case reported by Mr. Douglass, Lond. Med. Gaz., vol. xxvi. p. 509.

‡ One of the best-marked cases of this kind is the one reported by Mr. Hawkins, Lond. Med. Gaz., 1840, p. 447.

Although it may appear singular to some, yet I do not hesitate to place the somewhat noted case of Sir Astley Cooper in the same category. A large tumour was found in the mammary gland, but there appears to be no evidence that it was of a cartilaginous nature, except its external and internal aspects; and it certainly is to be regretted that the proof of its nature was allowed to rest upon this evidence alone.

The parotid gland is a favourite locality of these alleged enchondromatous growths; but in nearly all the recorded cases there is no positive evidence of their definite character. From a careful perusal of those in which true cartilage structure was found by the microscope,[*] I am inclined to the opinion that their primitive blastema was derived from the contiguous osseous tissue, although all these earlier relations had been changed by the subsequent progress of the disease.

There are also a few cases in which the testicle appears to have been the seat of this disease.

So far as I am aware,[†] however, those recorded by Müller are the only ones of which sufficient examination was made to remove all doubt. Concerning these, I cannot offer any opinion, because the details of their history are not sufficient so to do. But I will say of those that are to occur in the future, that it belongs to observers to carefully study their existing relations in reference to this point; for, in scientific pursuits of this kind, it is well known that an opinion is valuable just in proportion to the number of the relations that were taken into consideration when the observations on which it is based were made.

The importance of this point, which is now daily recognized in zoological studies, belongs equally to pathology. One may observe a phenomenon very carefully and thoroughly, but, as regards a certain point in it, he is not qualified to pass a scientific opinion unless, *at the time*, his attention was especially directed to it. The interpretation of nature is difficult, even under the most favourable circumstances; and science can never rest on a solid basis if dependent upon such careless observations. Aside from the bearing it may have upon cases previously alluded to, this point is well illustrated by what has been recorded of the so-called cartilaginous formations on the surface of the spleen, throughout works on pathological anatomy. To the observer it appears like cartilage, and he calls it thus, without thinking of any of those important histological relations which such a view would imply. And here on this point I may observe that, in several cases in which I have had the good fortune to meet with this product, a careful microscopical examination revealed *no* cartilaginous structure, although it could not have been judged otherwise from external aspects. The same is also true of apparent cartilaginous deposits on the surface of *other* serous membranes, so far as my own observation goes; they are *fibro-plastic structures.*

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[*] I refer particularly to the case of Müller (loc. cit. p. 124), and to the case of Prof. J. H. Bennett (On Cancer and Cancroid Growths, Obser. xxxix.).

[†] Mr. Gamjee's pamphlet, "On a Case of Ossifying Enchondroma in the Testis of a Horse," quoted by Mr. Paget (Lectures on Tumours), Lond. Med. Gaz, Aug. 1851, I have not seen.

From this brief review of the recorded cases of enchondron of the soft parts, as bearing upon its fundamental histological relations, it will be seen that I am quite disinclined to adopt the view that it can thus *spontaneously* occur; and I shall be much surprised if future experience does not substantiate the above opinion. At the same time it must be remembered that, as we have already learned some of the highest physiological truths, as expressed in an erratic form in pathological processes; so we must not shut our eyes to the phenomena of the latter, even when what have been considered established laws of the former are at stake; and, I may add, the best lessons of pathology in this connection have yet to be learned. There is, however, one point that should never be forgotten: it is that, when isolated facts concerning morbid processes come in direct contact with physiological laws, based upon the phenomena of normal organic life, these facts cannot be too carefully observed, or too strictly recorded. The occurrence of enchondroma, as a simple epigenesis, or connected with the normal cartilaginous and osseous tissues of the body, is, as before observed, much more frequent than the alleged other form we have just been discussing. It then has no more points of interest than belong to any epigenesis; the variations of different cases being, for the most part, referable to size, shape, and locality.[*] The cartilages and bones of the extremities appear to be its favourite localities, and especially the bones of the hand; in fact, in more than half of all the cases it belongs to this locality. We cannot hazard even a conjecture as to the intimate causes of its appearance, when it occurs without external injury; there is good reason, however, to believe that these causes are, for the most part, of local nature; yet there is some evidence, from a few cases, that the relations it sometimes sustains to the system may be *general*, or even *hereditary.*[†]

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[*] Since the work of Müller, who enumerated all the veritable cases up to his time, the following is a reference to some of the cases about the nature of which little doubt can exist, from the evidence of locality, &c., although in many of them no microscopic or other analysis was made:—

Gluge. Anat. Physiol. Untersuch. sur Pathol., Minden et Jena, 1838–41, vol. ii. pp. 153–7 and 187–9.

Cruveilhier. Anat. Pathol. du Corps Humain, Paris, 1842, livr. 34, pl. 4 and 5.

Frogley. Med.-Chir. Trans., 1843, vol. xxvi. p. 133.

Goodsir. Lond. and Edin. Month. Journ., Feb. 1843, p. 171.

Hertz. De Enchondromate. Erlangen, 1843; quoted by Vogel.

Adams. London Lancet, 1847, vol. ii. p. 463.

Bennett, On Cancer and Cancroid Growths. Edinb. 1849; Obser. xlviii. and ix.

Fergusson. London Lancet, 1850, vol. i. p. 455.

Lloyd. London Lancet, Dec. 1850.

Kingdon. London Med. Gaz., Sept. 5, 1851.

[†] See Ancell, Med.-Chir. Trans., vol. xxv. art. xv. Also Cobbald, Edin. Month. Journ., Aug. 1851.

As would be expected, it is most likely to occur in young persons; for, being an off-shoot of the type-power of the tissue, it would be most apt to take place when this power was in its greatest activity.

The appearances found on microscopical examination are considerably uniform as to primary constituents; although these are considerably altered, oftentimes, by changes that may subsequently supervene. These appearances belong almost entirely to those of normal fibro-cartilage; differing, however, from it, in this respect, that in the diseased product the cartilage corpuscles seem grouped, many of them in a single areola; while, in the normal tissue, they are more scattered, each areola containing generally one or two only. In comparatively few cases, true cellular cartilage is met with; and then is quite like that found in the embryo, or in cartilaginous fishes.

The amount of fibrous tissue found is very variable, sometimes in such excess as almost to exclude the real cartilage element, and then, again, quite small in quantity. This is a fact of considerable importance, since it shows that in many cases there could be no way to distinguish them from fibrous tumours, except by the apprehension of the cartilage corpuscles by the microscope. But while, on the one hand, they may be confounded with fibrous growths, on the other they are undoubtedly, in many cases, regarded as truly carcinomatous; and a study by the microscope of the changes they may experience as to their elements, shows clearly how this mistake is made. They undergo what is called a degeneration, terminating in softening and partial liquefaction. In these instances the fibrous tissue forming the areolæ, is broken up, and the cartilage cells become loose and isolated, and, from a retrograde metamorphosis of their tissue, oleo-albuminous particles appear in their interior, so as almost to entirely obscure their original appearance.* When these changes have occurred, the tumour has a softened, pulpy feel and aspect, and quite resembles some forms of carcinoma; and this not only externally, but so much so structurally, that the microscopist need have great care to avoid error. On these accounts, those who have experience in these matters cannot be too careful in pronouncing their opinion, where all opportunities for analysis are not afforded.

The *ossification* of enchondroma may occur in two ways: the one, by an extension of that part of the bone on which it rests into it; the other, by this process occurring, as it usually does, centrally, and from the cartilage itself.

Vogel† says that true enchondromata do not ossify; but he says this because he thinks there exist two distinct forms of cartilaginous tumour, viz.: *cartilaginous exostosis* and *enchondroma.* This may be really true; but I think, in most cases, it will be difficult to make the distinction good, because all enchondromata, it appears to me, are only *epigeneses.*

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* See the case of Lebert, Physiol. Pathologique, Paris, 1845, tom. ii. p. 213. Also a case by Bennett, on Cancer and Cancroid Growths, Edinb., 1849, Obser. xxxviii.

† The Pathological Anatomy of the Human Body. Translated by Dr. Day, London, 1849, p. 212.

Sometimes centres of ossification will be found in quite small tumours; while, in other cases, in those that are enormously large, no trace of bone-tissue can be found; so that we seem as yet entirely unacquainted with those primitive conditions on which this process in these morbid products depends. It is well known that all pathological tissues, whether of an homomorphous or an heteromorphous nature, are really *infra-formations;* that is, they never in any case reach the standard of the normal product; and if epigenetic, however much they may resemble the tissue from which they spring, they are certainly different in the fact of wanting that definite end and aim which belong to all true tissues. On this account, we should not look for the formation of true bone in the majority of cases of enchondroma. And I believe it is true that it is met with in comparatively few instances. In some instances, you have the passage of a few of the cartilage corpuscles into the caudate, or spiked corpuscles of bone; and, at some points, these may be sufficiently numerous to form osseous spicula; but I think it rare that you have in these products a series of processes, so closely resembling those of the normal tissue, that *true bone,* with concentric lamellæ, Haversian canals, and Purkinjean corpuscles, is the result. In some specimens, I have noticed that there appeared a disposition of the cartilage corpuscles to arrange themselves in linear series; in fact, I think this will be found true of all those that have been of long standing.

As examples of this disease in connection with the hand, I select the two following cases, which, in other respects, have many points of difference:—

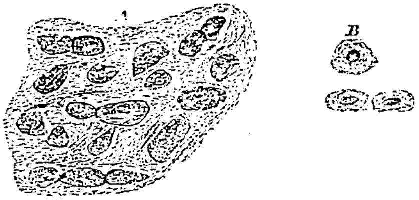
CASE I.—E. L., æt. 13, entered the Massachusetts General Hospital June 27th, 1850. Reported then that three years previous she fell, striking right hand upon the ground, and forcibly bending back the ring finger. Soon after there appeared, in present locality, a small tumour of the size of a pea, not tender or attended with pain. The increase to present size has since been gradual and without symptoms of any kind. At time of entrance there was a firm unyielding tumour, two-thirds of an inch in diameter, just behind the metacarpo-phalangeal joint of the ring finger, and seemingly connected with the metacarpal bone; not tender, and not impeding motion of finger.

It was removed by Dr. S. D. Townsend, and was found to have an attachment, as had previously appeared, with the extremity of the bone.

Incised.—The surface had a semi-translucent, sago-like aspect, a little spongy but still rather firm to the feel. No appearance of osseous matter.

Under the microscope, the tissue appeared composed of irregular-shaped, and rather solid-looking, corpuscles; varying in size from $\frac{1}{2000}$th to $\frac{1}{300}$th of an inch in diameter, the lighter ones having a granular aspect, and all were nucleated, and some with two or three nuclei. Acetic acid affected them quickly, rendering them more transparent and the nucleus more prominent.

These corpuscles, exactly like those of cartilage, were situated in a semitransparent gelatiniform matrix, having but little fibrous tissue or scarce any areolar arrangement.

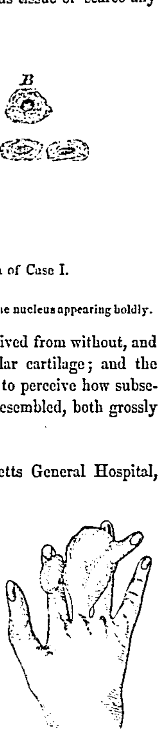


Microscopical Appearances of the Enchondroma of Case I.

A. Cartilage corpuscles in their granular stroma.
B. Appearance of corpuscles after being treated with acetic acid; the nucleus appearing boldly.

In this case, the epigenesis was due to an injury received from without, and approached in character quite closely that of true cellular cartilage; and the fibrous element being almost entirely absent, it is easy to perceive how subsequently, after central softening, it would have closely resembled, both grossly and microscopically, encephaloid cancer.

Case II.—M. M., æt. 13, entered the Massachusetts General Hospital, May, 1850. Reported then that general health had always been good. Eleven years before, and being only two years of age, the tumour of the middle finger commenced without known cause. Some time afterwards, but does not know exactly how long, the tumour on the forefinger appeared. Both of these have increased uniformly to present size, without any inconvenience except from bulk. At time of entrance there was a smooth, round, elastic tumour about one inch in diameter, situated on the outside of the first, and part of the second phalanges of middle finger, crowding it outward and directly across the ring finger, at nearly a right angle. The integuments covering it were smooth, with enlarged veins ramifying over it.



Appearance of Hand of Case II. before operation. One-fifth natural size.

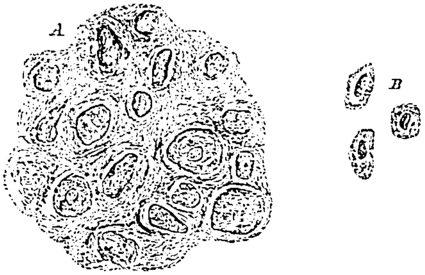
On the inside of middle phalanx of forefinger was another tumour of similar character, but only one-third of its size. There was a third quite small, at middle joint of ring finger, but concealed by that of the last. None of these were tender on pressure.

The middle finger was removed by Dr. J. Mason Warren. It was found that the shaft of the metacarpal bone had almost entirely disappeared, but the upper extremity remained.

Incised.—The surface of the tumour presented an homogeneous aspect, semi-translucent, grayish white, and not unlike that of a fresh section of an English turnip. It had a spongy feel, and was easily scraped away.

Under the microscope, the structure was found to be almost wholly cellular, consisting of cells of an oblong and oval shape, prominent, and with a well-marked granular aspect. In some places there appeared a tendency to an arrangement in a longitudinal series. In other parts they existed as doublets or triplets, looking like a very long oblong cell divided into two or three parts. By acetic acid the whole was somewhat cleared up, and a distinct nucleus or nuclei in each was apparent.

These corpuscles were situated in a very delicate and almost transparent *nidal stroma,* with scarce a trace of true fibrous tissue. Some of these cells, in the very centre of the tumour, had passed on to the formation of the spiked osseous corpuscles.



Microscopical Appearances of Enchondroma of Case II.

A. Cartilage corpuscles, single, in doublets, and in triplets, lying in their fine granular stroma.
B. The same corpuscles treated with acetic acid, revealing prominently the nucleus.

In this case, its manifold appearance did not belong, apparently, to any external violence, but it is to be referred to *constitutional* causes.

Boston, *Nov.*, 1851.